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(54) Title: ADJUVANTS FOR HERBICIDAL COMPOSITIONS

(57) Abstract

The present invention is directed to an adjuvant composition for use in herbicidal compositions. The adjuvant includes an amine alkaline compound and a non–ionic surfactant, and is substantially free of a neutral ammonium salt composition.

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ADJUVANTS FOR HERBICIDAL COMPOSITIONS

This invention relates to two component water soluble adjuvant compositions for use in spray carriers containing postemergence herbicides, which are used to control weeds or other undesired vegetation.

BACKGROUND OF THE INVENTION

Herbicides used in controlling weeds or undesired vegetation in agriculture are customarily applied by postemergence spraying of a herbicide on the crop. The spray carrier for the herbicide is usually a water based solution containing an effective amount of known herbicide.

Adjuvants are commonly added to herbicidal spray solutions to enhance postemergence weed control and/or to reduce spray drift during herbicide applications.

Postemergence weed control requires that the spray containing the herbicide be retained on the weed surface for that purpose. To obtain that result, many "sticker" compositions or agents, including methylated vegetable oils or mineral based oils and wetting (surface/active) agents are marketed for spray solution adherence of the herbicide by the weeds and in addition help retain droplets of the spray solution on the plant and to penetrate into the plant.

In addition to spray retention by the weed, other additives in the form of liquid nitrogen based fertilizer solutions have been found, for example, to enhance the control of wild oats by herbicides such as Barban. Miller et al., Weed Science, 1978, Vol. 4, pp. 344-348. Recently surfactants have been combined with liquid fertilizers (usually 28% nitrogen and comprising a mixture of 50% ammonium nitrate and 50% urea). The results however are variable depending on surfactants

used and nitrogen fertilizer employed. It was found that certain salts and surfactants influence nicosulfuron, for example, and its herbicide activity. Nalewaja et al., Weed Technology, 1995, Vol. 9, pp. 587-593.

Some acidic additives have previously been used which are designed to lower pH and enhance the acidity of the spray carrier water formulation which was believed to both benefit herbicide adsorption and also to prevent alkaline hydrolysis of certain insecticides. Acids and buffering agents are sometimes also used to reduce antagonism from alkaline salts found in the spray carrier water.

It has been noted that adjuvants differ greatly in herbicide enhancement depending on the specific surfactant and the herbicide used in some cases resulting in decreased performance. Halloway, 4th International Symposium on Adjuvants for Agrochemicals, 1995, FR. & Bulletin, No. 193).

Adjuvants which are a three component system including an alkaline amine pH regulator, a non-ionic surfactant, and a neutral ammonium such as ammonium nitrate, ammonium chloride, and ammonium sulfate are described in U.S. Patent No. 5,658,855. All three components were required to provide the desired phytotoxicity.

SUMMARY OF THE INVENTION

The present invention relates to adjuvant compositions for use in the spray carrier of postemergence herbicides applied as an aqueous spray solution to areas infested with undesired weeds or plants to control the same. The adjuvant composition is substantially free of neutral ammonium salts which act as a fertilizer and or herbicidal enhancer. The present invention does not require neutral ammonium salts, such as ammonium nitrate, ammonium chloride and ammonium

sulfate, to provide an enhancement of herbicidal activity.

The adjuvant composition of the invention is a two component composition that includes an amine or ammonia compound which is a base for adjusting the pH to the alkaline range, and a non-ionic surface active agent with a high Hydrophilic-Lipophilic Balance (HLB), which functions as a spreader or sticker and penetrant for use with postemergence herbicides.

In an important aspect of the invention, the basic or alkaline amine pH regulator of the invention is effective for providing an alkaline pH of above about 7 up to about 9 to the final spray solution that is applied to the plants. Alkaline compounds effective for providing a basic spray solution may include various amine or ammonium compounds which are employed in amounts of up to about 30% by weight of the adjuvant composition. Amine type compounds useful in the present invention include ammonium hydroxide, and water soluble amines such as monoethanolamine, diethanolamine, triethanolamine and 2-amino-2-ethyl-1,3-propanediol.

The second component of the adjuvant composition of the present invention is a non-ionic surfactant. In an important aspect of the invention, the non-ionic surfactants have a high HLB (Hydrophilic-Lipophilic Balance) above about 12 to about 18. The non-ionic surfactant component ranges from about 25 to about 95 percent by weight of the adjuvant composition.

In another aspect, the invention, the adjuvant compositions of the present invention are diluted with water and blended with a herbicide in herbicidally effective amounts and applied for weed control purposes. The herbicide is customarily added to the adjuvant/water solution at the recommended label amount, for example, in an amount effective for providing an application rate of broadly from about 0.12 to about 2 ounces per acre of the active herbicide ingredient.

In an important aspect of the invention, the adjuvant composition and herbicidal spray composition of the invention is substantially free of a neutral ammonium salt composition and still remains as effective as a herbicidal adjuvant with three components that includes an ammonium salt. Neutral ammonium salt compositions include nitrogen fertilizers such as ammonium nitrate, ammonium chloride, ammonium nitrate-urea fertilizer solutions, and ammonium sulfate. In this aspect of the invention, less than effective amount of neutral ammonium salt composition means less than about 1% by weight based on the weight of the adjuvant composition and less than about 0.1% by weight based on the weight of the herbicidal spray composition.

DETAILED DESCRIPTION

The adjuvant of the present invention is a two component mixture including an alkaline amine pH regulator and a non-ionic surfactant, the adjuvant being substantially free of neutral ammonium salts. The two component adjuvant composition of the present invention increases the efficacy of certain herbicides. The elimination of a third ammonium salt component, for example a ammonium fertilizer, allows for the production of a more concentrated product that can be used at lower percentages. In an important aspect, the two component adjuvant of the invention is as effective as the three component adjuvant described in U.S. Patent No. 5,658,855 for increasing the herbicidal activity of the same herbicide at the same concentrations of adjuvant and herbicide. "Substantially free" of neutral ammonium salts having a fertilizer enhancing action means that the adjuvants of the invention do not have amounts of these salts which are effective for fertilizer or herbicidal enhancing activity, such as less than about 1 wt % of the adjuvant, when the adjuvant is applied in an effective amount as a part of a herbicidal spray.

Alkaline Amine pH Regulator

In an important aspect of the invention, high pH in combination with surfactants increased phytotoxicity of herbicides and resulted in a fresh weight reduction of weeds. The combination of high pH and surfactant resulted in increased phytotoxicity to weeds by at least 12% at low spray volumes of about 80 L/ha.

The alkaline amine pH regulator of the invention provides an alkaline pH of the final spray solution of above about 7 up to about 9. The upper limit of pH chosen should not be so high as to result in hydrolysis of the herbicidal use. In an important aspect of the invention, the lower pH limit should be slightly above 7 in the alkaline range, for example, 7.25.

In another important aspect of the invention, the alkaline component is free of calcium or sodium cations. As used herein, "free of calcium or sodium cations" or "substantially free of herbicidally antagonistic amounts of calcium or sodium cations" means that the alkaline component has less than about 0.01 percent by weight calcium or sodium cations. Alkaline components which contain calcium or sodium cations should be avoided since these are considered antagonistic to many herbicides.

Alkaline compounds which include nitrogen are especially important in the present invention. Preferred alkaline compounds used to provide an alkaline spray solution are various amine or ammonium compounds which are employed in amounts of up to about 30% by weight of the adjuvant composition. Useful amine type compounds are ammonium hydroxide, and water soluble amines. Amines such as monoethanolamine, diethanolamine, triethanolamine and 2-amino-2-ethyl-1,3-propanediol are examples of preferred pH regulators.

Non-Ionic Surfactant

The second component of the adjuvant composition is a non-ionic surfactant preferably secondary or linear

(primary) alcohols or other non-ionic surfactants having a high HLB (Hydrophilic-Lipophilic Balance) broadly above about 12 to about 18; preferably between 13 and 17. The non-ionic surfactant may also be block copolymers of various HLB's.

High HLB indicates that a surfactant molecule is relatively more water than oil soluble. One system of obtaining HLB is by dividing the water soluble portion of the surfactant molecule by 5. HLB values for surfactants are usually provided by the surfactant supplier and are also available from McCutcheon's Emulsifiers & Detergents, McCutcheon Division, McCutcheon Publishing Co., 175 Rock Road, Glen Rock, NJ 07452). High HLB's of the present invention are considered hydrophilic. In an important aspect of the invention, water soluble herbicides are enhanced more by high than low HLB surfactants.

Examples of suitable non-ionic surfactants having a high HLB are ethoxylated alkylphenols, Triton X-100 (HLB 13.5), Triton X-102 (HLB 14.6), Triton X-165 (HLB 15.8), Triton X-305 (HLB 17.3) from Union Carbide Corporation, Igepal CO-610 (HLB 12.2), CO-660 (HLB 13.2), CO-720 (HLB 14.2), CO-730 (HLB 15), CO-887 (HLB 17.2) from Rhone-Poulenc, GENAPOL 24-L-75, an ethoxylated alcohol, product of Hoechst Celanese Corp., (HLB 10.9); Pluronics, block copolymers of propylene oxide and ethylene oxide, products of BASF Corp., (P103, HLB up to 12; P104, HLB 12-18); Tween 20, polyoxethylene (20) sorbitan monolaurate, product of ICI Surfactants, (HLB 16.7); and Tergitol 15-S-9, a secondary alcohol ethoxolate, a product of Union Carbide Corp., (HLB 13.3). The non-ionic surfactant component ranges between 25 to 95% by weight of the adjuvant, with a preferred range of 50 to 75% by weight of the adjuvant mixture.

Formulation of Adjuvant

The adjuvant is customarily formulated and sold in two and one half (2½) gallon or larger batches which are used to make up the spray mixture which includes spray water (about 99%) and a herbicidally effective amount of a postemergence herbicide.

The adjuvant of the present invention is effective for use with herbicides whose solubility is increased by high pH, which includes sulfonylureas and weak acid herbicides. The surfactant of the present invention acts to help spray retention and absorption by plants and the high pH maintains the herbicide in a more efficacious chemical form for absorption.

Preferably, the herbicides employed in this invention are selected from the group consisting of:

Nicosulfuron (sold under the tradename Accent) which is the compound [[[[(4,6-demethoxy-2-pyrimidinyl) amino]carbonyl] amino]sulfonyl-N,N-dimethyl-3-pyridine carboxy amide;

Sulfsulfuron (sold under the tradename Maverick) which is the compound 1-(2-ethylsulfonylimidazo(1,2-a)pyridin-3-ylsulfonyl)-3(4,6-dimethoxypyrimidin-2-yl)urea; and

Quinchlorac (sold under the tradename Facet) which is the compound 3,7-dichloro-8-quinolinecarboxylic acid.

Sulfonylurea and imidazolinone herbicides such as rimsulfuron (Matrix), N((4,6-dimethoxypyrimidin-2yl)aminocarbonyl0-3-(ethysulfonly)-2-pyridinesulfonamide; trisulfuorn (UpBeet), methyl-2-[[[[[4-(dimethylamino)-6-(2,2,2-trifluoroethoxy)-1,3,5-triazin-2-yl]amino]carbonyl]amino]sulfonyl)-3-methylbenzoate; imazethapyr (Pursuit), imazamox, (±)-2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-ethyl-3-pyridinecarboxylic acid; (Raptor) 2-(4-isopropyl-4-methlyl-5-oxo-2-imidazolin-2-yl)-5-(methoxymethyl) nicotrinoic acid, and mixtures thereof.

In an important aspect, this invention includes aqueous herbicidal spray compositions containing adjuvant compositions of the invention comprising:

(A) an amino alkaline pH regulator compound selected from the group consisting of ammonium hydroxide; monoethanolamine, diethanolamine, triethanolamine, and 2-amino-2-ethyl-1,3-propanediol and mixtures thereof in sufficient amount to provide a pH of from about 7.25 to about 9 in the final diluted aqueous composition;

(B) a non-ionic surface active agent having an HLB of from about 12 to about 18 in an amount from about 25% to about 95% by weight of said adjuvant composition;

(C) water to make 100%;

(D) an effective amount of a postemergence herbicide; and

(E) additional water to make up the final spray solution.

The post emergence herbicidal aqueous spray composition utilizing the adjuvant compositions of this invention comprise from about 0.15 to 0.8% and preferably 0.2 to 0.5% of a non-ionic surfactant having a high Hydrophylic-Lipophylic Balance (HLB); an alkaline amine type pH regulator selected from the group consisting of ammonium hydroxide, monoethanol amine, diethanolamine, triethanolamine and 2-amino-2-ethyl-1,3-propanediol in an amount to provide a pH of from about 7.25 to about 9 in the final aqueous solution.

EXAMPLES

Example 1

The effect of surfactant, pH and spray volume on weight reduction of crabgrass was tested as shown in Table 1. High pH in combination with Tergitol 15-S-, Igepol CO, and Triton X surfactants was positive to increasing nicosulfuron phytotoxicity to large crabgrass as measured by fresh weight reduction (Table 1). Both

the high pH and the surfactant enhanced the efficacy of nicosulfuron regardless of spray volume. At the low spray volume of 80 L/ha increasing the pH from 4 to 9 with ammonium hydroxide increased the effectiveness of all three types of surfactants regardless of surfactant HLB. At the high spray volume of 240 L/ha the benefit from high pH was limited to the less effective surfactants.

Table 1. Large crabgrass percentage fresh weight reduction from nicosulfuron at 15g/ha as influenced by secondary alcohol ethoxylate (Tergitol®) nonylphenoxypoly (ethylenoxy) ethanol (Igepal CO) and octylphenoxy (Triton®-X) surfactants at 0.25 (v/v) and spray carrier volume and pH.

			pH4[b]		pH9[b]	
			Spray carrier, L/ha			
	Treatment[a]	HLB[c]	80	240	80	240
			--% fresh weight reduction--			
	None	---	1	3	-7	-9
	Tergitol®15-S-5	10.5	16	62	20	71
	Tergitol®15-S-7	12.1	28	79	46	79
	Tergitol®15-S-9	13.3	36	83	73	83
	Tergitol®15-S-12	14.5	60	81	77	83
	Tergitol®15-S-15	15.4	52	82	83	83
	Tergitol®15-S-20	16.3	47	82	81	85
	Tergitol®15-S-30	17.4	20	81	81	83
	Tergitol®15-S-40	18.0	1	74	75	84
	LSD 5%		--------- 5 ---------			
	None	--	0	10	5	8
	Igepal CO 430	8.8	6	49	31	57
	Igepal CO 530	10.0	21	63	51	79
	Igepal CO 610	12.2	50	93	90	95
	Igepal CO 660	13.2	50	93	90	95
	Igepal CO 720	14.2	49	95	93	94

Igepal CO 730	15.0	53	9	95	96
Igepal CO 887	17.2	27	89	88	91
Igepal CO 997	19.0	9	69	75	82
LSD 5%	19.0	9	69	75	82
	--------	6	---------		
None	--	1	-10	-3	-5
Triton®X-45	10.4	0	21	1	11
Triton®X-114	12.4	13	54	49	60
Triton®X-100	13.5	7	71	68	84
Triton®X-102	14.6	9	76	80	85
Triton®X-165	15.8	3	85	76	84
Triton®X-305	17.3	-5	72	70	79
Triton®X-405	17.9	-11	58	48	65
LSD 5%	--------	9	---------		

[a]Igepal Surfactants are from Rhone-Poulenc, Cranberry, NJ, Tergitol® products and Triton® X from Union Carbide, Danbury CT.
[b]pH4 was hydrochloric acid and 9 by ammonium hydroxide.
[c]HLB is the surfactant hydrophilic-lipophilic-balance value.
[d]LSD is Least Significant Difference.

Example 2

Table 2 show that the addition of ammonium nitrate to the adjuvant composition did not further enhance nicosulfuron efficacy with Tergitols in a distilled water carrier.

Table 2. Large crabgrass percentage fresh weight reduction from nicosulfuron at 15 g/ha as influenced by ethoxylated secondary alcohol (Tergitol® 15-S) surfactants at 0.25% (v/v) and ammonium nitrate

percentage (w/v) in the distilled water alone and with 0.02M sodium bicarbonate applied at 160 L/ha.

		Ammonium nitrate, %				
Adjuvant[a]	HLB[b]	None	0.25	0.5	1.0	2.0
Distilled Water		% fresh weight reduction				
None	--	7	2	2	1	1
Tergitol® 15-S-5	10.5	25	55	50	48	76
Tergitol® 15-S-7	12.1	67	88	88	87	88
Tergitol® 15-S-9	13.3	82	91	92	91	90
Tergitol® 15-S-12	14.5	90	82	77	67	65
Tergitol® 15-S-15	15.4	90	80	53	53	46
Tergitol® 15-S-20	16.3	89	76	36	23	22
Tergitol® 15-S-30	17.4	89	52	35	16	15
Tergitol® 15-S-40	18.0	76	28	10	15	9
LSD 5%		---------- 5 ----------				
Sodium bicarbonate						
None	--	0	7	7	.4	.0
Tergitol® 15-S-5	10.5	2	49	62	72	73
Tergitol® 15-S-7	12.1	27	77	85	82	84
Tergitol® 15-S-9	13.3	33	92	90	87	85
Tergitol® 15-S-12	14.5	54	87	87	84	79
Tergitol® 15-S-15	15.4	64	87	83	80	71
Tergitol® 15-S-20	16.3	66	80	81	76	63
Tergitol® 15-S-30	17.4	72	78	76	68	60
Tergitol® 15-S-40	18.0	42	65	56	52	35
LSD 5%		---------- 6 ----------				

[a]Tergitol® surfactants from Union Carbide, Danbury, CT.
[b]HLB is the surfactant hydrophilic-lipophilic-balance value.

Example 3

Table 3 demonstrates the effect of different surfactants and material used to increase pH on % weight reduction of crabgrass.

Table 3. Large crabgrass control from Nicosulfuron at 15 g/ha with pH material.

Pluronic®[a] surfactant	pH material[b] None	TEA (7.8)	$NaHCO_3$(8)
	% fresh weight reduction		
L-62	48	84	68
P-85	45	83	82
P103	77	84	78
L122	71	86	77

[a]Products of BASF Corp., Mount Olive NJ.
[b]TEA = triethanolamine; $NaHCO_3$ = sodium bicarbonate; and values in parenthesis are pH.

Example 4

Table 4 shows the effect of high pH from various ammonium compounds. Ammonium hydroxide, dibasic phosphate, and tribasic citrate were most effective in the enhancement of nicosulfuron with either X-77 or Tween 20 surfactants.

Table 4. Large crabgrass response to nicosulfuron at 15 g/ha as influenced by 0.15M nitrogen salts applied with surfactant X-77 and Tween 20 in an 80 L/ha spray.

	Surfactants[a]	
Nitrogen salt	X-77	Tween 20
	% fresh weight reduction	
None	13	30
Ammonium hydroxide	67	82
Ammonium bisulfate	17	37
Ammonium sulfate	23	32
Ammonium nitrate	23	20
Ammonium chloride	24	35
Ammonium phosphate, monobasic	17	26
Ammonium phosphate, dibasic	72	84
Ammonium citrate, dibasic	65	61
Ammonium citrate, tribasic	75	80
LSD 5%	------ 5 -------	

[a]X-77 from Loveland Industries, Greeley, CO and Tween 20 from ICI Surfactants, Wilminton DE.

Example 5

Table 5 shows the effect of pH, fertilizer and surfactant on the efficacy of sulfsulfuron herbicide.

Table 5. Japanese brome response to MON 37532 as influenced by ammonium fertilizer and various surfactants.

	pH or fertilizer[b]		
LAE surfactant[a]	None	High pH	High pH+AMN
	% fresh weight reduction		
810-40	65	83	82
60	72	86	84
80	49	82	83
1214-40	54	78	82
60	61	84	82
80	63	86	87
1618-46	7	64	73
62	37	84	83
80	71	84	89
LSD 5%	------ 7 ------		

[a]LAE = linear alcohol ethoxylates.
[b]High pH from triethanolamine and AMN = ammonium nitrate fertilizer.

Example 6

Table 6 shows the effect of pH, and surfactant on the efficacy of quinchlorac herbicide.

Table 6. Green foxtail response to quinchlorac at 105 g/ha as influenced by pH changing salts with linear alcohol ethoxylate surfactant 1214-80, greenhouse.

Material[a]	pH	Green foxtail % control
None	2.4	51
Na OH	10.9	41
NH4OH	9.9	60
Ca $(OH)_2$	10.6	10
TEA	7.1	65
LSD 5%		2

[a]Amount equal to herbicide on molar basis.

What Is Claimed Is:

1. An adjuvant composition for use in aqueous herbicidal spray compositions comprising:

an amine alkaline compound in an amount effective for providing an alkaline pH of above about 7 to about 9 when formulated in a final spray composition; and

a non-ionic surfactant having a hydrophilic-lipophilic balance (HLB) of at least about 12, in an amount of from about 25 to 95 percent by weight of the adjuvant, the adjuvant composition being substantially free of a neutral ammonium salt composition.

2. An adjuvant composition according to claim 1 wherein the amine alkaline compound comprises up to about 30% by weight of the composition.

3. An adjuvant composition according to claim 1 wherein the amine alkaline compound is selected from the group consisting of ammonium hydroxide, organic water soluble amines and mixtures thereof.

4. An adjuvant composition according to claim 1 wherein the amine alkaline compound is selected from the group consisting of ammonium hydroxide, monoethanolamine, diethanolamine, triethanolamine and 2-amino-2-ethyl-1,3-propanediol and mixtures thereof.

5. An adjuvant composition according to claim 1 wherein the non-ionic surfactant has an HLB of from about 12 to about 18.

6. An adjuvant composition according to claim 1 wherein the non-ionic surfactant is a primary or secondary alcohol.

7. An adjuvant composition according to claim 1 wherein the non-ionic surfactant is a block copolymer.

8. An adjuvant composition according to claim 6 wherein the non-ionic surfactant is present in an amount of from about 25 to about 95% by weight of the adjuvant composition.

9. An adjuvant composition according to claim 1 wherein the alkaline compound is present in an amount sufficient to provide a pH of at least about 7.25 when formulated in a final aqueous spray solution.

10. An adjuvant composition according to claim 1 wherein the adjuvant composition is substantially free of herbicidally antagonistic amounts of calcium or sodium cations.

11. An aqueous postemergence herbicidal spray composition which comprises:

an adjuvant composition, the adjuvant composition comprising an amine alkaline pH regulator compound selected from the group consisting of ammonium hydroxide, monoethanolamine, diethanolamine, triethanolamine, and 2-amino-2-ethyl-1,3-propanediol and mixtures thereof in sufficient amount to provide a pH of from about 7.25 to about 9 in the final diluted aqueous composition, and a non-ionic surface active agent having an HLB of from about 12 to about 18 in an amount of from about 25 to about 95% by weight of said adjuvant composition;

water to make 100%;

an effective amount of a postemergence herbicide; and

additional water to make up the final spray solution, the adjuvant composition being substantially free of a neutral ammonium salt composition.

12. A herbicidal spray composition according to claim 11 wherein the herbicide is selected from the group

consisting of nicosulfuron, sulfsulfuron, quinchlorac, rimsulfuron, trisulfuron, imazethapyr, imazamox and mixtures thereof.

13. A herbicidal spray composition according to claim 12 wherein the herbicide ranges from about 0.005 to about 2% of the final diluted aqueous spray composition.

14. A herbicidal spray composition according to claim 11 wherein the adjuvant composition is substantially free of herbicidally antagonistic amounts of calcium or sodium cations.

15. A method of controlling weeds which comprises applying a postemergence herbicidal spray composition to weeds and/or other undesired vegetation, the herbicidal spray composition comprising:

an amine alkaline pH regulator compound selected from the group consisting of ammonium hydroxide, monoethanolamine, diethanolamine, triethanolamine, and 2-amino-2-ethyl-1,3-propanediol and mixtures thereof in sufficient amount to provide a pH of from about 7.25 to about 9 in the final diluted aqueous composition;

a non-ionic surface active agent having an HLB of from about 12 to about 18 in an amount of from about 25% to about 95% by weight of said adjuvant composition;

water to make 100%;

an effective amount of a postemergence herbicide; and

additional water to make up the final spray solution, the spray composition having being substantially free of a neutral ammonium salt composition.

16. A method according to claim 15 wherein the herbicide is selected from the group consisting of

nicosulfuron, sulfsulfuron, quinchlorac, rimsulfuron, trisulfuron, imazethapyr, imazamox, and mixtures thereof.

17. A method according to claim 15 wherein the herbicide ranges from a concentration of about 0.005 to about 2% of the final diluted aqueous spray composition.

18. An adjuvant composition for use in aqueous herbicidal spray compositions consisting essentially of:

an amine alkaline compound in an amount effective for providing an alkaline pH of above about 7 to about 9 when formulated in a final spray composition; and

a non-ionic surfactant having a hydrophilic-lipophilic balance (HLB) of at least about 12, in an amount of from about 25 to about 95 percent by weight of the adjuvant, the adjuvant composition being substantially free of a neutral ammonium salt composition.

19. An adjuvant composition according to claim 18 wherein the amine alkaline compound comprises up to about 30% by weight of the composition.

20. An adjuvant composition according to claim 18 wherein the amine alkaline compound is selected from the group consisting of ammonium hydroxide, organic water soluble amines and mixture thereof.

21. An adjuvant composition according to claim 18 wherein the amine alkaline compound is selected from the group consisting of ammonium hydroxide, monoethanolamine, diethanolamine, triethanolamine and 2-amino-2-ethyl-1,3-propanediol and mixtures thereof.

22. An adjuvant composition according to claim 18 wherein the non-ionic surfactant has an HLB of from about 12 to about 18.

23. An adjuvant composition according to claim 18 wherein the non-ionic surfactant is a primary or secondary alcohol.

24. An adjuvant composition according to claim 18 wherein the non-ionic surfactant is a block copolymer.

25. An adjuvant composition according to claim 23 wherein the non-ionic surfactant is present in an amount of from about 25 to about 95% by weight of the adjuvant composition.

26. An adjuvant composition according to claim 18 wherein the alkaline compound is present in an amount sufficient to provide a pH of at least about 7.25 when formulated in a final aqueous spray solution.

27. An adjuvant composition according to claim 18 wherein the adjuvant composition is substantially free of herbicidally antagonistic amounts of calcium or sodium cations.

28. An adjuvant composition for use in aqueous herbicidal spray compositions comprising:

an amine alkaline compound in an amount effective for providing an alkaline pH of above about 7 to about 9 when formulated in a final spray composition; and

a non-ionic surfactant having a hydrophilic-lipophilic balance (HLB) of at least about 12, in an amount of from about 25 to 95 percent by weight of the adjuvant, the adjuvant composition being substantially free of a neutral ammonium salt composition,

the adjuvant being as effective as a three component herbicidal adjuvant that includes a neutral ammonium salt.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/04686

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :A01N 25/24

US CL :504/214, 215, 253, 362

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 504/214, 215, 253, 362

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

none

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Please See Extra Sheet.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,658,855 A (NALEWAJA et al) 19 August 1997, see entire document.	1-28
Y	US 3,964,896 A (BROUWER et al) 22 June 1976, see columns 9-10 and 20.	1-28
Y	NALEWAJA et al. Salts and Surfactants Influence Nicosulfuron Activity. Weed Technology. 1995, Vol. 9, pages 587-593, see entire document.	1-28
Y	GREEN et al. Surfactant Structure and Concentration Strongly Affect Rimsulfuron Activity. Weed Technology. 1993, Vol. 7, pages 633-640, see entire document.	1-28

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

*	Special categories of cited documents:	"T"	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A"	document defining the general state of the art which is not considered to be of particular relevance	"X"	document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"E"	earlier document published on or after the international filing date	"Y"	document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"L"	document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"&"	document member of the same patent family
"O"	document referring to an oral disclosure, use, exhibition or other means		
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search	Date of mailing of the international search report
15 JUNE 2000	05 JUL 2000
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer S. Mark Clardy JOYCE BRIDGERS PARALEGAL SPECIALIST CHEMICAL MATRIX Telephone No. (703) 308-1235

Form PCT/ISA/210 (second sheet) (July 1998)★

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US00/04686

B. FIELDS SEARCHED
Electronic data bases consulted (Name of data base and where practicable terms used):

WEST: monoethanolamine, diethanolamine, triethanolamine, amino-ethyl-propanediol; nicosulfuron, sulfosulfuron, quinchlorac, rimsulfuron; trisulfuron, imazethapyr, imazamox; nonionic + surfactant/surface active